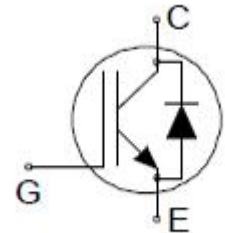
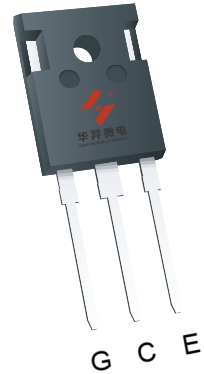


Feature

- 650V/40A
 $V_{CE(sat)} = 1.65V(\text{typ.}) @ I_C = 40A$
- Positive temperature coefficient
- Fast Switching
- Low $V_{CE(sat)}$
- Reliable and Rugged
- Halogen Free and Green Devices Available
(RoHS Compliant)

Pin Description



Applications

- Motor drives
- Solar Inverter
- Resonant converters

Ordering and Marking Information

 W HYG40T65 XYMXXX	Package Code W:TO-247-3L Date Code XYMXXX
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Note: HUAYI halogen free products contain molding compounds/die attach materials and 100% matte tin plate Termination finish; which are fully compliant with RoHS. HUAYI halogen free products meet or exceed the halogen free requirements of IPC/JEDEC J-STD-020 for MSL classification at halogen free peak reflow temperature. HUAYI defines "Green" to mean halogen free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

HUAYI reserves the right to make changes, corrections, enhancements, modifications, and improvements to this product and/or to this document at any time without notice.

Absolute Maximum Ratings

Symbol	Parameter		Rating	Unit
Common Ratings (Tc=25°C Unless Otherwise Noted)				
V _{CES}	Collector-Emitter Voltage		650	V
V _{GES}	Gate-Emitter Voltage		± 30	V
T _J	Junction Temperature Range		-55 to 175	°C
T _{STG}	Storage Temperature Range			°C
Mounted on Large Heat Sink				
I _{CM}	Pulsed Collector Current *	Tc=25°C	160	A
I _C	Continuous Drain Current	Tc=25°C	80	A
		Tc=100°C	40	A
I _{FM}	Diode Maximum Forward Current *	Tc=25°C	160	A
I _F	Diode Continuous Forward Current	Tc=25°C	80	A
		Tc=100°C	40	A
R _{θJC}	Thermal Resistance, Junction-to-Case (IGBT)		0.66	°C/W
R _{θJC}	Thermal Resistance, Junction-to-Case (Diode)		0.58	°C/W
R _{θJA}	Thermal Resistance, Junction-to-Ambient		40	°C/W

Note: * Repetitive rating: pulse width limited by max. junction temperature.

Electrical Characteristics (Tc = 25°C Unless Otherwise Noted)

Symbol	Parameter	Test Conditions	HYG40T65F1DHW			Unit
			Min	Typ.	Max	
Static Characteristics*						
BV _{CES}	Collector-Emitter Breakdown Voltage	V _{GE} =0V, I _C =250μA	650	-	-	V
I _{CES}	Collector-Emitter Leakage Current	V _{CE} =650V, V _{GE} =0V	-	-	10	μA
V _{GE(th)}	Gate Threshold Voltage	V _{CE} =V _{GE} , I _C =1mA	4.3	5.3	6.3	V
I _{GES}	Gate-Emitter Leakage Current	V _{GE} =± 20V, V _{CE} =0V	-	-	±200	nA
V _{CE(sat)}	Collector-Emitter Saturation Voltage	V _{GE} =15V, I _C =40A, T _J =25°C	-	1.65	1.95	V
		V _{GE} =15V, I _C =40A T _J =125°C	-	2.00	-	V
		V _{GE} =15V, I _C =40A T _J =175°C	-	2.15	-	V
V _F	Diode Forward Voltage	I _F =40A, T _J =25°C	-	2.20	2.55	V
		I _F =40A, T _J =125°C	-	1.84	-	V
		I _F =40A, T _J =175°C	-	1.62	-	V

Dynamic Characteristics						
C _{ies}	Input Capacitance	V _{GE} =0V	-	2540	-	pF
C _{oes}	Output Capacitance	V _{CE} =25V	-	126	-	
C _{res}	Reverse Transfer Capacitance	Frequency=1MHz	-	67	-	
Q _g	Total Gate Charge	V _{CC} =520V	-	146	-	nC
Q _{ge}	Gate- Emitter Charge	I _C =40A	-	24	-	
Q _{gc}	Gate- Collector Charge	V _{GE} =15V	-	71	-	
t _(SC)	Short circuit collector current Max.1000 short circuits, times between short circuits: ≥ 1.0s	V _{GE} =15V, V _{CC} ≤400V T _J ≤175°C	-	8	-	μs
IGBT Switching Characteristics, at T _J =25°C						
t _{d(ON)}	Turn-on Delay Time	I _C =40A V _{CC} =400V V _{GE} =15V R _g =5Ω	-	20	-	ns
t _r	Turn-on Rise Time		-	67	-	
t _{d(OFF)}	Turn-off Delay Time		-	104	-	
t _f	Turn-off Fall Time		-	74	-	
E _{on}	Turn-On Switching Loss	T _J =25°C	-	0.95	-	mJ
E _{off}	Turn-Off Switching Loss	Inductive Load	-	0.93	-	
E _{ts}	Total Switching Loss		-	1.88	-	
IGBT Switching Characteristics, at T _J =175°C						
t _{d(ON)}	Turn-on Delay Time	I _C =40A V _{CC} =400V V _{GE} =15V R _g =5Ω	-	22	-	ns
t _r	Turn-on Rise Time		-	73	-	
t _{d(OFF)}	Turn-off Delay Time		-	178	-	
t _f	Turn-off Fall Time		-	70	-	
E _{on}	Turn-On Switching Loss	T _J =175°C	-	1.82	-	mJ
E _{off}	Turn-Off Switching Loss	Inductive Load	-	1.16	-	
E _{ts}	Total Switching Loss		-	2.98	-	
Diode Characteristics, at T _J =25°C						
t _{rr}	Reverse Recovery Time	I _F =40A di/dt=200A/μs	-	188	-	ns
Q _{rr}	Reverse Recovery Charge		-	243	-	nC
I _{rrm}	Reverse Recovery Current		-	6.8	-	A
Diode Characteristics, at T _J =175°C						
t _{rr}	Reverse Recovery Time	I _F =40A di/dt=200A/μs	-	215	-	ns
Q _{rr}	Reverse Recovery Charge		-	278	-	nC
I _{rrm}	Reverse Recovery Current		-	9.7	-	A

Note: *Pulse test, pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$

Typical Operating Characteristics

Figure 1: Power Dissipation

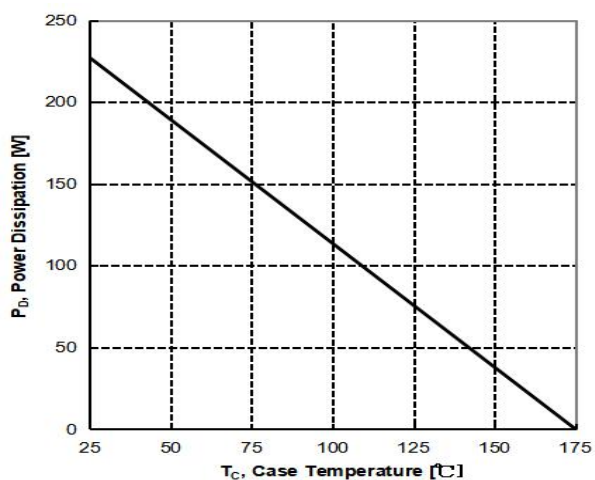


Figure 2: Collector Current vs. Case Temperature

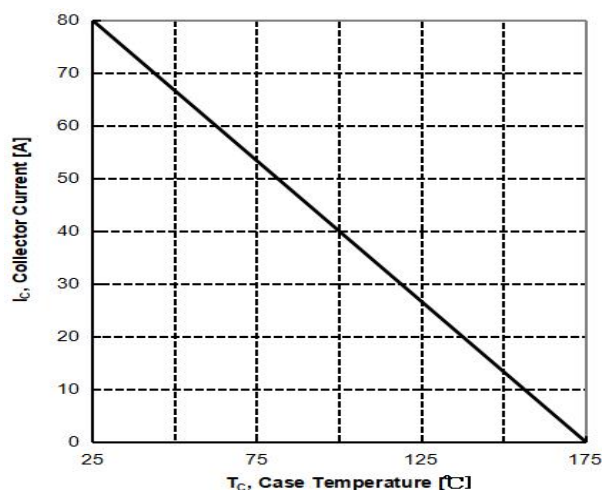


Figure 3: Safe Operation Area

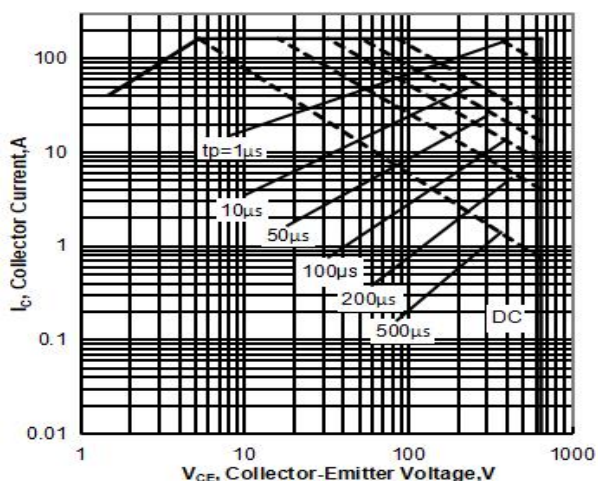


Figure 4: Typical Transfer Characteristics

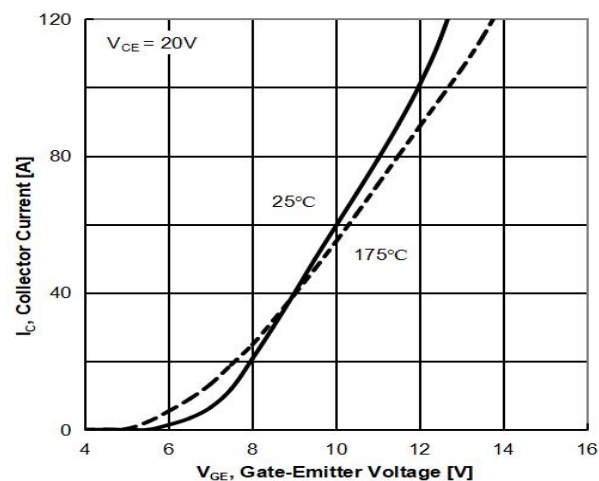


Figure 5: Typical Output Characteristics

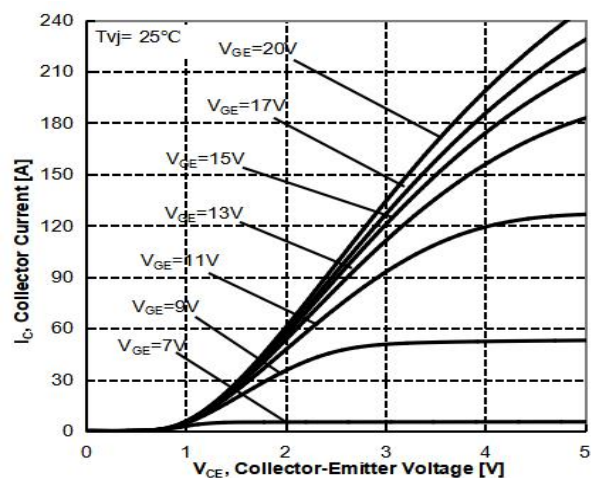


Figure 6: Typical Output Characteristics

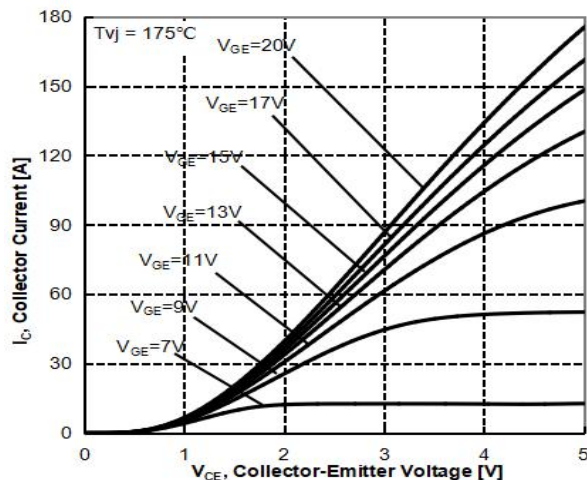


Figure 7: Typical Collector-Emitter Saturation Voltage vs. Junction Temperature

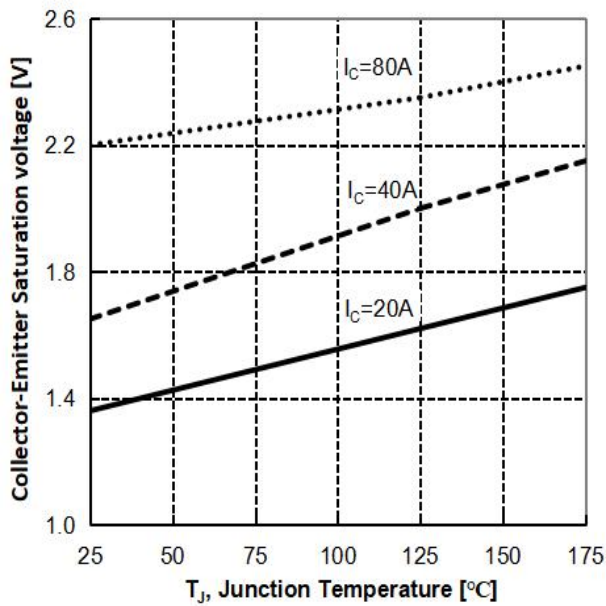


Figure 8: Typical Gate-Emitter Threshold Voltage vs. Junction Temperature

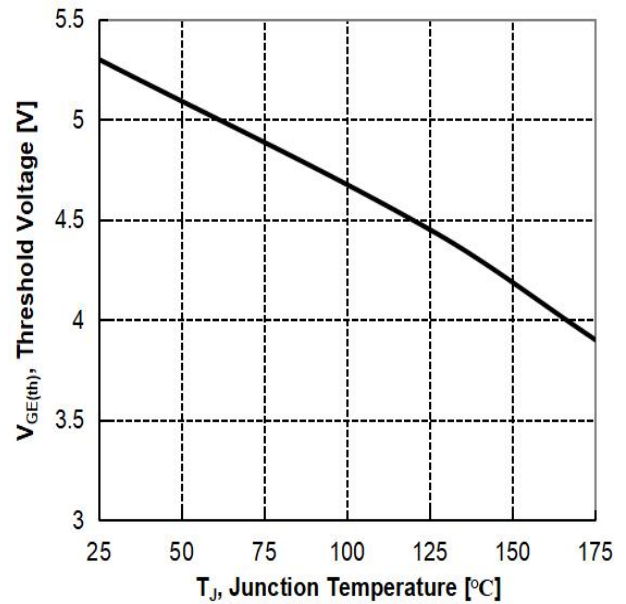


Figure 9: Typical Switching Times vs. Gate Resistor ($T_J=25^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

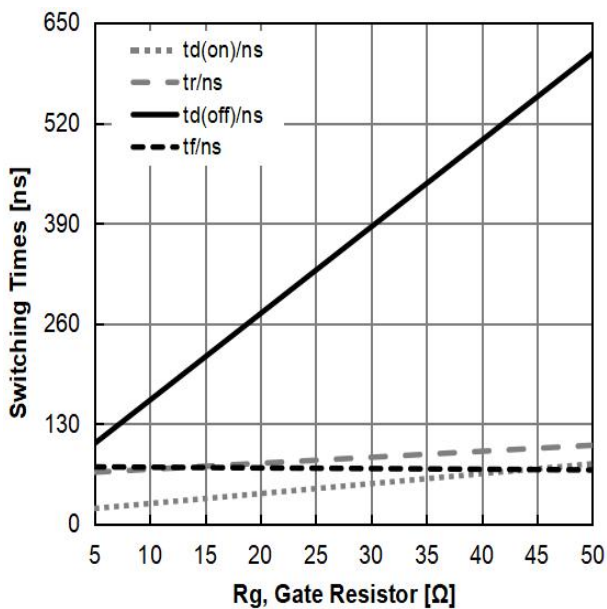


Figure 10: Typical Switching Energy vs. Gate Resistor ($T_J=25^\circ\text{C}$, $V_{CE}=400\text{V}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

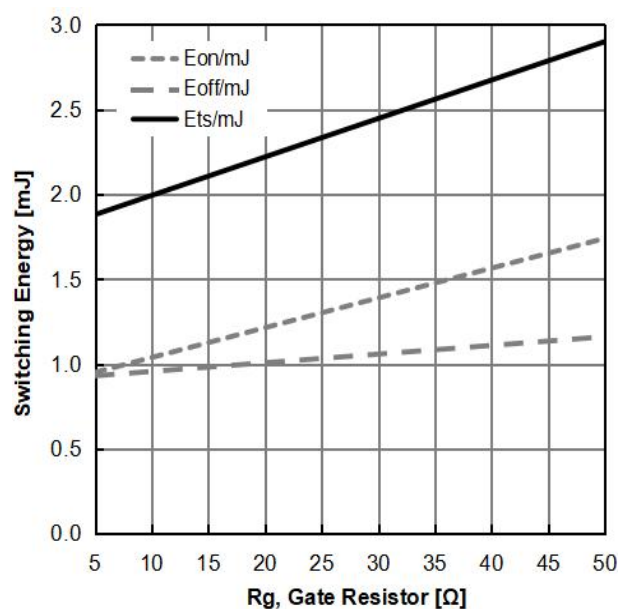


Figure 11: Typical Switching Times vs. Junction Temperature ($V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=40A$)

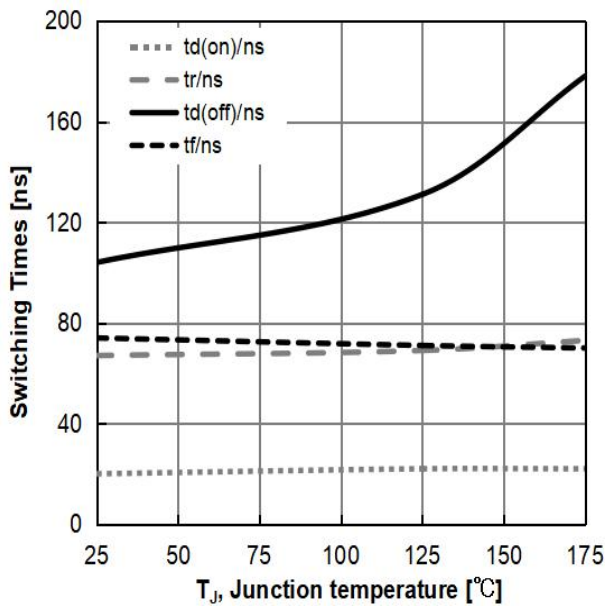


Figure 12: Typical Switching Energy vs. Junction Temperature ($V_{CE}=400V$, $V_{GE}=15/0V$, $I_C=40A$)

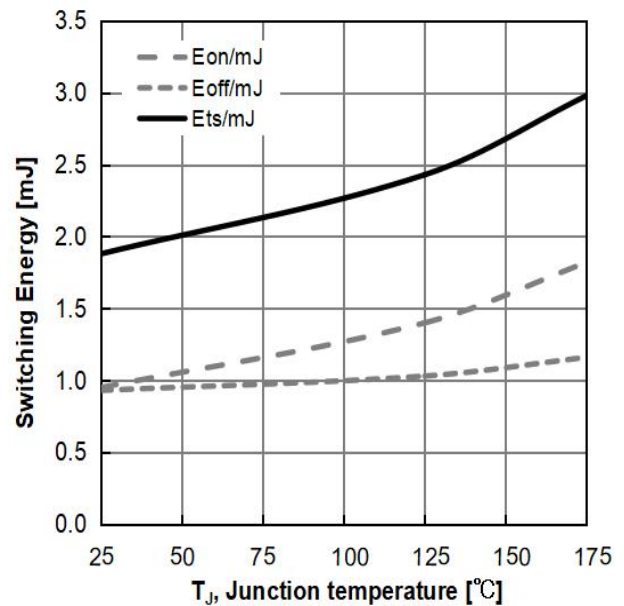


Figure 13: Typical Switching Times vs. Collector Current ($T_J=25^\circ C$, $V_{CE}=400V$, $V_{GE}=15/0V$)

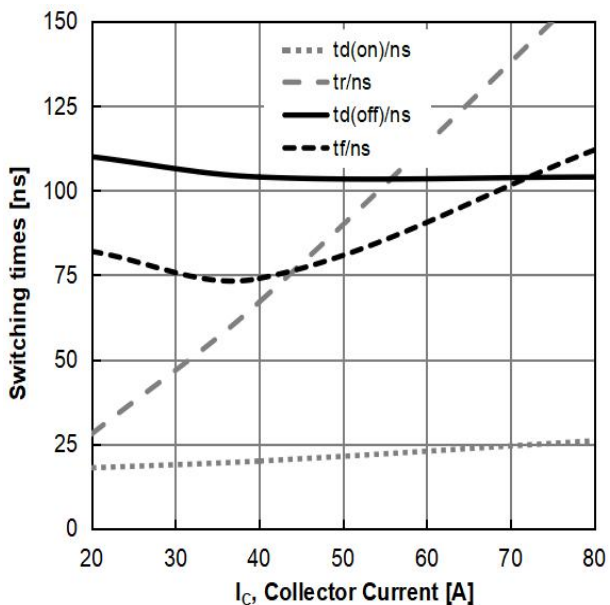


Figure 14: Typical Switching Energy vs. Collector Current ($T_J=25^\circ C$, $V_{CE}=400V$, $V_{GE}=15/0V$)

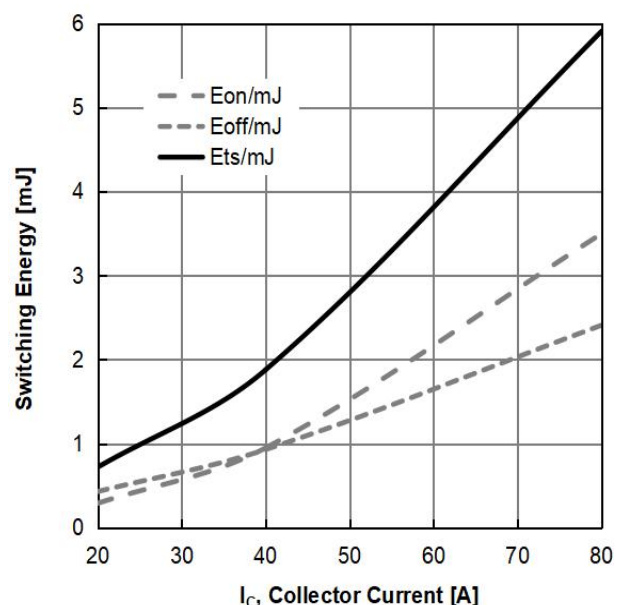


Figure 15: Typical Switching Times vs. VCE ($T_J=25^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

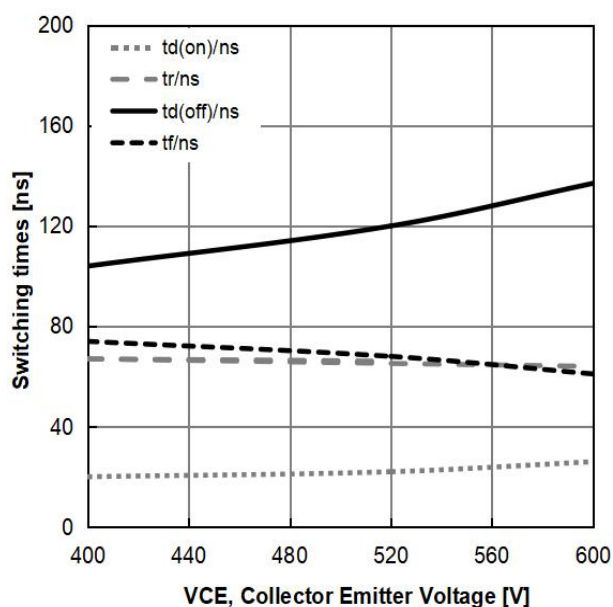


Figure 16: Typical Switching Energy vs. VCE ($T_J=25^{\circ}\text{C}$, $V_{GE}=15/0\text{V}$, $I_C=40\text{A}$)

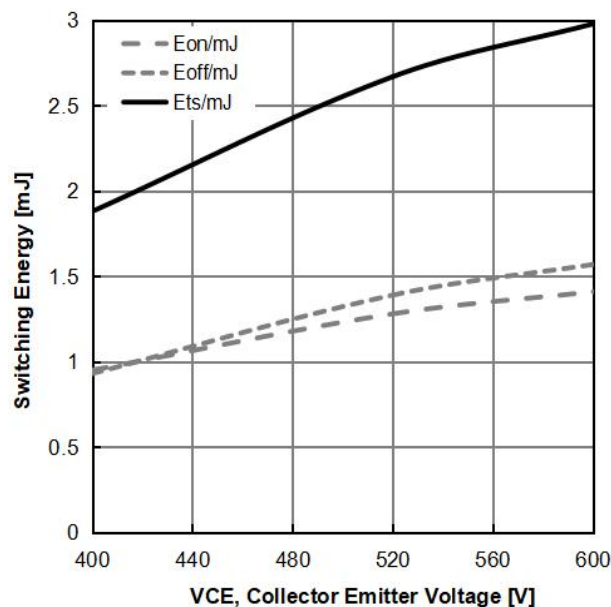


Figure 17: Typical Gate Charge

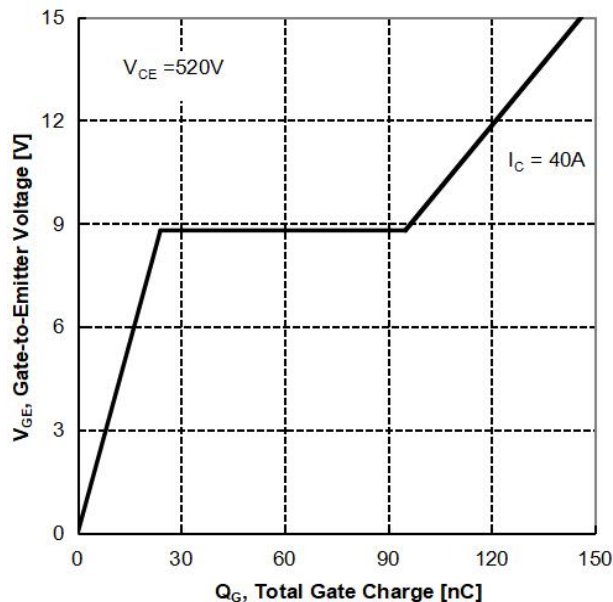


Figure 18: Typical Capacitance vs. Collector- Emitter Voltage

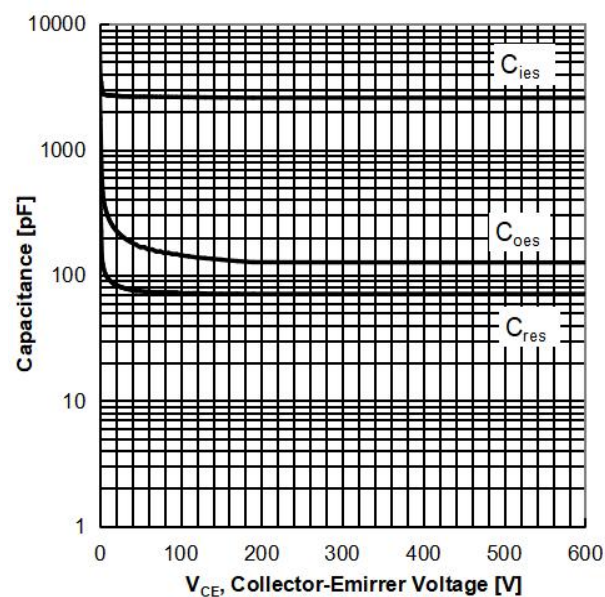


Figure 19: IGBT Transient Thermal Impedance vs. Pulse Width

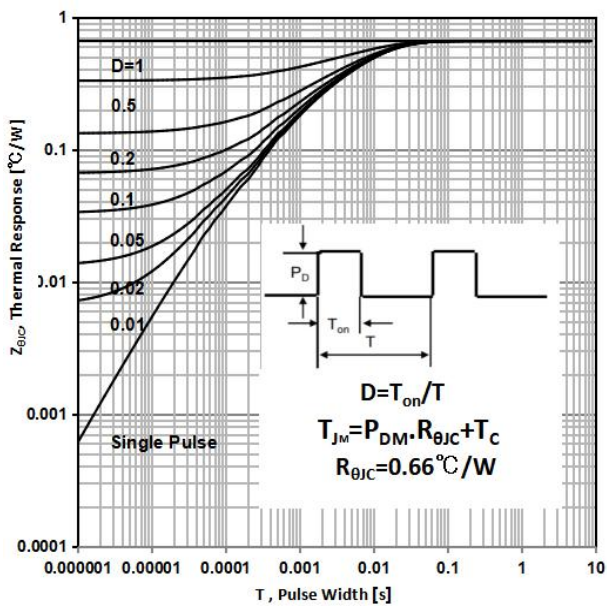


Figure 20: Diode Transient Thermal Impedance vs. Pulse Width

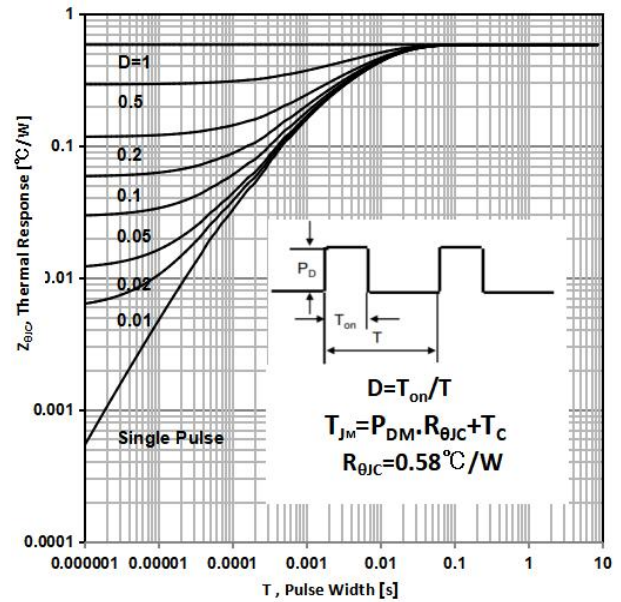
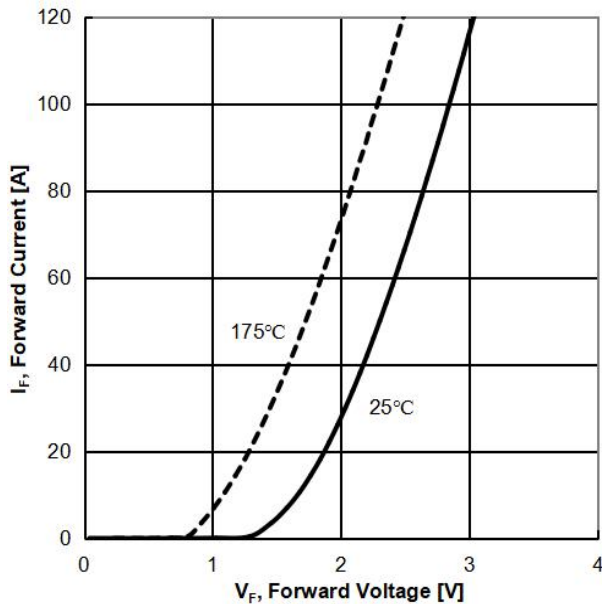
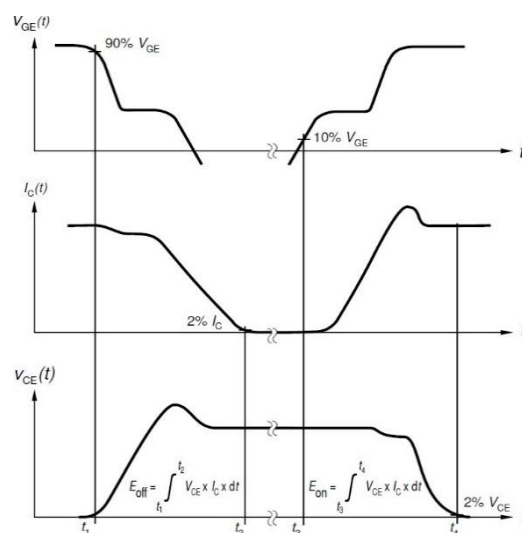
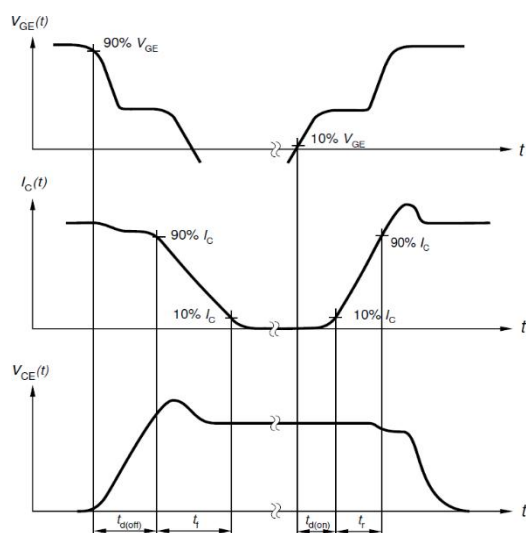


Figure 21: Typical Diode Forward Current vs. Forward Voltage



The diagram shows a DC voltage source V_{DC} connected to a parallel combination of two semiconductor devices: a Diode Under Test (DUT) and an IGBT Under Test (DUT). The IGBT is driven by a gate resistor R_G connected to a pulse source. Both devices share a common emitter terminal. The collector terminals are connected in parallel to an inductive load L , which is then connected to the negative terminal of the DC source.

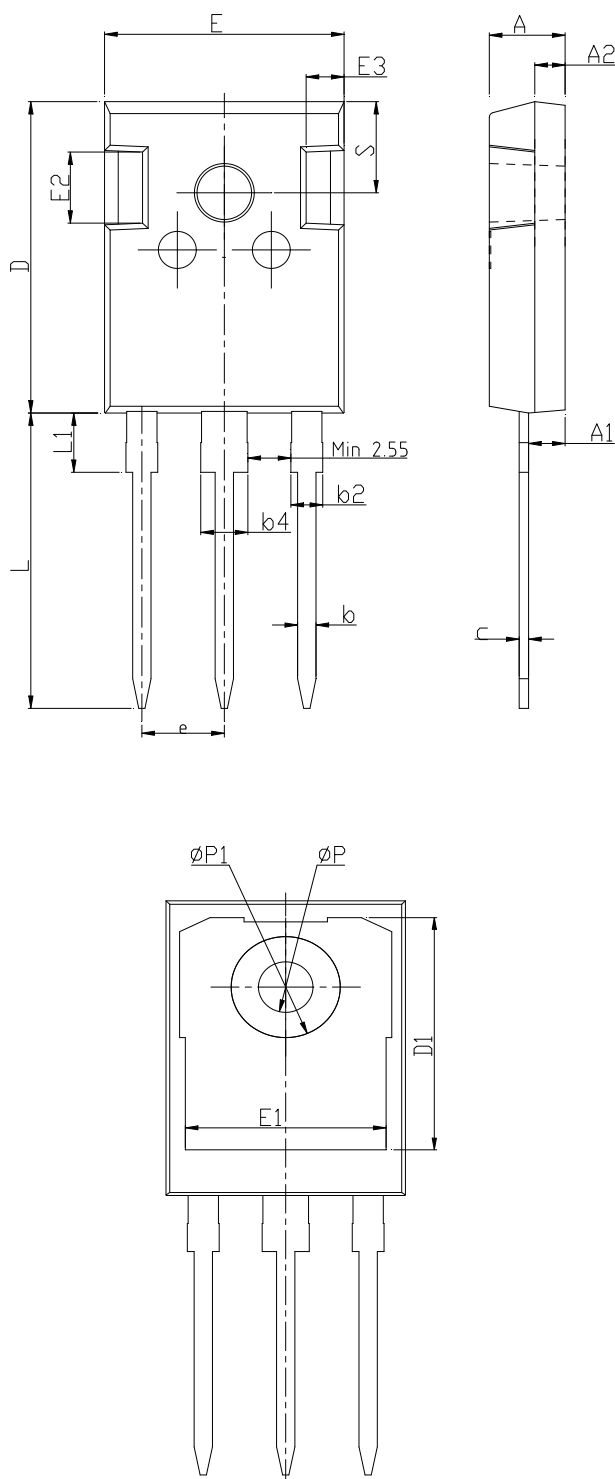


Device Per Unit

Package Type	Unit	Quantity
TO-247-3L	Tube	30

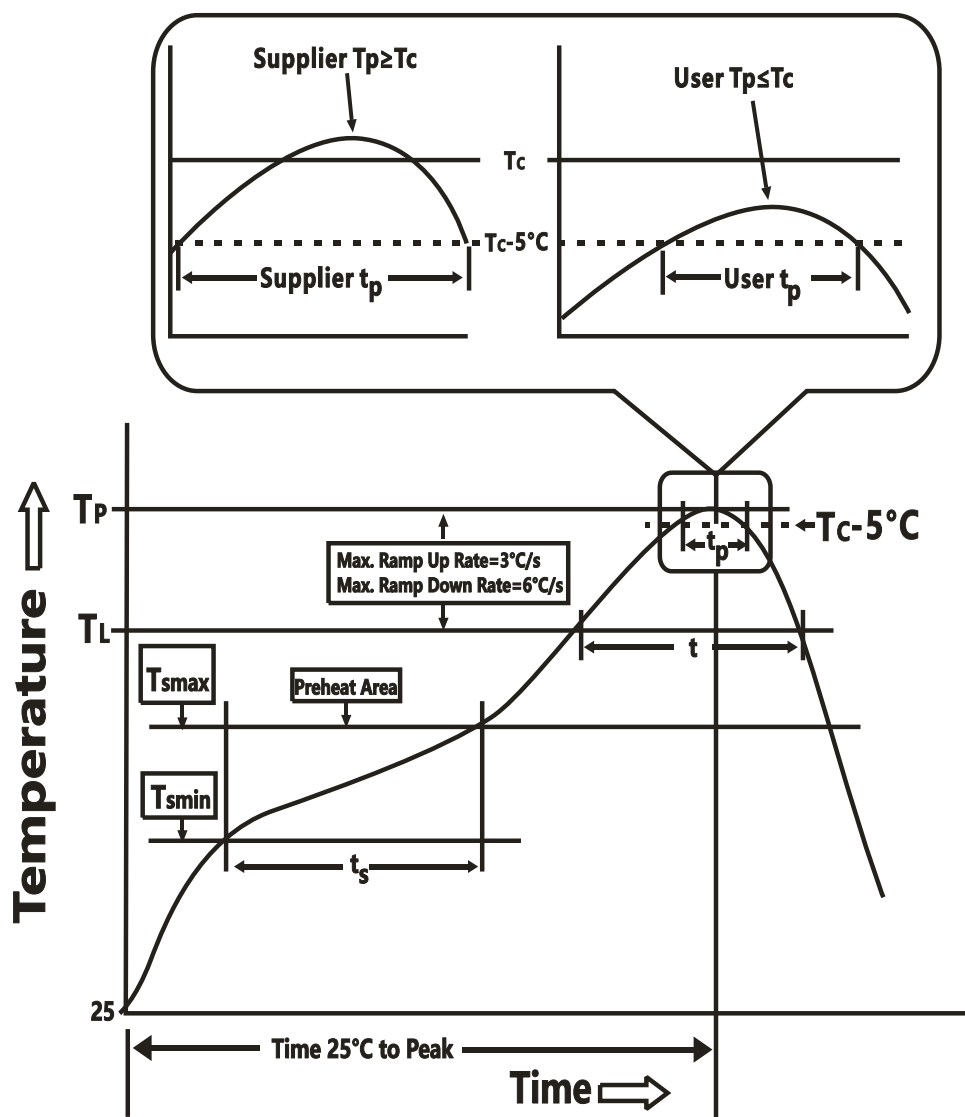
Package Information

TO-247-3L



COMMON DIMENSIONS			
SYMBOL	mm		
	MIN	NOM	MAX
A	4.80	5.00	5.20
A1	2.21	2.41	2.59
A2	1.85	2.00	2.15
b	1.11	1.21	1.36
b2	1.91	2.01	2.21
b4	2.91	3.01	3.21
c	0.51	0.61	0.75
D	20.70	21.00	21.30
D1	16.25	16.55	16.85
E	15.50	15.80	16.10
E1	13.00	13.30	13.60
E2	4.80	5.00	5.20
E3	2.30	2.50	2.70
e	5.44BSC		
L	19.62	19.92	20.22
L1	-	-	4.30
ΦP	3.40	3.60	3.80
ΦP1	-	-	7.30
S	6.15BSC		

Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak		
Temperature min (T_{smin})	100 °C	150 °C
Temperature max (T_{smax})	150 °C	200 °C
Time (T_{smin} to T_{smax}) (t_s)	60-120 seconds	60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L)	183 °C	217 °C
Time at liquidous (t_L)	60-150 seconds	60-150 seconds

Peak package body temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (T_p)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
*Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum.		
** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1.Sn-Pb Eutectic Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2.Pb-free Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ ≥2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
HTRB	JESD-22, A108	168/500 Hrs, Bias @ 150°C
HTGB	JESD-22, A108	168 /500 Hrs, 100%V _{GE} @ 150°C
PCT	JESD-22, A102	96 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	250/500 Cycles, -55°C~150°C

Revision History

HYG40T65F1DHW

Revision:2024-02-11, Rev.1.0

Revision	Date
1.0	2024-02-11

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